Contract No.: EP-W-09-002
WA #: 023-RARA-02PE

Region 2 RAC2
Remedial Action Contract

Simulation of Extraction Well for Southern Groundwater Plume Memorandum

Old Roosevelt Field Contaminated Groundwater Area Superfund Site

Remedial Action

Garden City, New York

August 29, 2012

213331

CDM Smith

Old Roosevelt Field: Simulation of Extraction Well for Southern Groundwater Plume Memorandum

The Old Roosevelt Field groundwater model was previously calibrated to measured groundwater head data collected in April and July 2006 and was used to evaluate various alternatives for the Feasibility Study (FS). The development of the groundwater model was documented in a technical memorandum dated August 13, 2007, which also serves as Appendix A of the Feasibility Study (FS).

In 2008, the ORF groundwater model was used to site an extraction well system to capture the 100 ppb portion of the plume, while minimizing impacts to head at the nearby Garden City supply wells, and siting the wells within the property constraints at the time (e.g., within the parking lot). Due to the thickness of the plume, a three well system was recommended, consisting of 60-foot screen intervals and spanning a depth from 210 to 410 feet below grade. The total extraction rate was simulated at 250 gpm of which 70 gpm was pumped from the shallow and intermediate wells and 110 gpm was pumped from the deep recovery well. Groundwater was to be treated and discharged to a recharge basin (Nassau County Basin #124) located immediately south of the Garden City supply wells. The Garden City supply wells (N-03934 and N-03935) are shown as GWP-10 and GWP-11 on Figure 1 and subsequent figures.

The extraction well system was installed and an aquifer test was conducted in 2010. The results of the aquifer test were used to verify the groundwater model and adjustments in model properties were made accordingly (CDM Smith, 2011).

Water quality data collected from wells throughout the study area indicate that the contaminant plume has migrated south of the Garden City supply wells. PCE and TCE concentrations collected from the deepest ports of SVP-11 in September 2011 were as high as 42 ug/L and 230 ug/L, respectively. The latest depiction of the plume is shown on Figures 2 and 3 in plan view and cross-section.

In order to prevent further migration of the TCE and PCE plume, a second extraction well system is being proposed immediately south of Stewart Avenue, across from the Stewart Avenue Elementary School located at the intersection of Stewart Avenue and Clinton Road, as shown in **Figure 4**. Groundwater would be routed to the location of the existing treatment plant and treated effluent would be discharged to the recharge basin. The existing plant will be upgraded to handle 500 gpm. As 250 gpm are already being utilized from the existing extraction system (EW-1), an additional 250 gpm is available.

The Old Roosevelt Field (ORF) groundwater model was used to determine if pumping up to 250 gpm from the school property was sufficient to contain the southern portions of the PCE and TCE plume. The primary objective was to capture the portion of the plume that is south of the Garden City supply wells and greater than 100 ug/L. The latest derivation of the TCE plume (**Figures 2 and 3**) was incorporated into the model and run for a 30-year period. Available data suggest that PCE concentrations do not exceed 100 ug/L downgradient of the Garden City supply wells. Therefore, contaminant transport simulations of PCE were not conducted. However, groundwater contributing

areas were simulated to evaluate groundwater capture at various depth intervals. Results of the model simulations are presented within this technical memorandum.

Groundwater Model

During late 2010 and early 2011, the ORF groundwater model was modified following simulation of the aquifer test that was conducted by the project team in the summer of 2010. The hydrogeologic properties of the model were adjusted somewhat and, in particular, the transmissivity of the middle portion of the Magothy aquifer within the study area was increased. Two variations of increased transmissivity were simulated in which the horizontal hydraulic conductivity was increased to 80 ft/day and one in which the increase was much more significant at 180 ft/day (in both cases, the vertical hydraulic conductivity was set to 2 ft/day). The model simulations for this effort utilized 80 ft/day as the horizontal conductivity of the middle Magothy aquifer as this is more consistent with typical Magothy aquifer properties on Long Island. The planar extent to which this coarser Magothy exists is uncertain. The groundwater model currently has the extent to the approximate location of Stewart Avenue.

The groundwater model used for previous simulations of the extraction well system upgradient of the Garden City wells has 15 model levels (14 layers) and 15,094 nodes. Because the southern portion of the plume is deeper and extends beneath the Garden City supply wells, additional vertical discretization was needed to be added at depth. Five model levels were added and horizontal discretization was also enhanced with the addition of 3,787 model nodes around the vicinity of Stewart Avenue Elementary School. The final grid is shown on **Figure 5** and in cross section on **Figure 6**. Additional information regarding model development can be found in previous reports and technical memoranda (CDM Smith, 2007; CDM Smith, 2008; CDM Smith, 2011).

As the groundwater model was calibrated during initial development and verified with the aquifer test simulations, additional calibration simulations were not conducted. Recent water supply pumping data (post-2009) are not currently available from Nassau County Department of Public Works (DPW). Ultimately, the model should be verified with additional head data collected from the site wells and updated with more recent pumping data prior to final design. Efforts are currently ongoing to obtain the pumpage data from NYSDEC.

Groundwater Model Simulations

Groundwater model simulations were conducted in the same fashion as during the design simulations for the upgradient extraction wells. Transient groundwater flow simulations were conducted using monthly time steps and average monthly water supply pumpage and recharge. A five year sequence of pumping and recharge representing 2003 through 2007 was repeated 5 times to create a 30-year DYNFLOW simulation. Additionally, steady state DYNFLOW simulations were applied to capture zone analyses. Average 2003-2007 pumping and recharge were assigned to the steady state capture zone simulations.

Groundwater flow simulations were conducted with EW-01 (upgradient extraction wells) pumping at 250 gpm continuously and all other community supply wells pumping at average monthly conditions between 2002 and 2007, consistent with previous modeling efforts. Treated effluent from both the

upgradient and southern extraction system was simulated to recharge at the Nassau County owned recharge basin 124 immediately south of the Garden City wells.

As described in more detail below, the southern extraction system was simulated using three co-located wells screened over different vertical intervals, similar to the upgradient extraction well system. Total simulated pumping from the wells was 225 gpm, and they are sited on the south end of the school property. A summary of the extraction wells is shown in **Table 1**. Simulated well locations are shown on **Figure 4**. Having a system consisting of three extraction wells allows for flexibility in changing pumping rates over time should the nature of the plume change from existing conditions.

Table 1
Remediation Well Depths and Pumping Rates

Well	Northing (ft)[1]	Easting (ft)[1]	Well Screen Elevation (ft, msl)	Simulated Pumping Rate (gpm)
SEW-01 (S)	205450	1089985	-275 to -335	50
SEW-01 (I)			-340 to -400	75
SEW-01 (D)			-410 to -470	100

NAD83, New York State Plane, U.S. Feet.

The wells were sited (horizontally and vertically) to capture the 100 ug/L portion of the TCE plume that is south of the Garden City supply wells and as defined by the project team (as mentioned earlier, PCE does not exceed 100 ug/L, based on available data). As shown on **Figure 3**, the base of the plume was not encountered (elevated concentrations in deepest ports from SVP-11, SVP-10). Therefore, as a conservative approach, the screen interval of the deep extraction well was sited down to 470 feet below mean sea level, close to the top of the Raritan Clay (as included within the model).

Simulated Pump and Treat (PT) Capture Zones

Simulated capture zones for the pump and treat scenario were developed for various depths in the aquifer. The capture zones were developed using a steady state simulation of the remedial pumping/recharge. Average areal recharge and water supply pumping based on the 5-year period from 2003 to 2007 was assigned. Pumping at Garden City wells for the steady-state conditions was 387.1 gpm at N-03934 (GWP 10) and 417.8 gpm at N-03935 (GPW 11), representing the average monthly pumping rates at the wells between 2003 and 2007. Pumping at the northern extraction system was held constant at 250 gpm. A total of 475 gpm was recharged at Nassau County basin 124.

Figures 7, 8 and 9 show the area of simulated hydraulic capture to SEW-01 in the aquifer at 50 foot increments from -50 ft, msl to -450 ft, msl. Capture zones are shown at -225 ft, msl and -320 ft msl to correspond to isoconcentration contour depths generated by the project team. The capture zone includes the areas of hydraulic capture to EW-01 within 15 years. The area in orange is simulated to be captured by the Garden City water supply wells.

Based on the simulated capture zones, pumping a three well sequence at a total of 225 gpm is sufficient to capture the 100 ppb portion of the TCE plume.

The deep extraction well (SEW-1D) is sited to capture PCE and TCE contamination deeper than -400 ft, msl. TCE concentrations exceeding 200 ug/L in Port 1 of SVP-11 (230 ug/L) may be indicative of elevated TCE (and perhaps PCE) concentrations at depth, below many of the existing wells. Elevated PCE and TCE concentrations in Port 1 of SVP-10, SVP-11, SVP-13 and SVP-14, support this possibility. Therefore, the deep well pumping conservatively extends the capture zone to capture upgradient PCE and TCE contamination at depths greater than the deepest monitoring wells.

Solute Transport Simulations

Solute transport simulations were developed in DYNTRACK using simulated transient groundwater flow fields. For each alternative, 30-year flow simulations were conducted using monthly areal recharge and water supply pumping data for the period from 2003 to 2007, repeated six times to model seasonal and annual hydrologic variations over thirty years.

Starting TCE Plume

The estimated initial TCE plume is based on updated isoconcentration contours defined by the project team (**Figure 3**). As mentioned above, the base of the TCE plume at SVP-11 was not encountered. Therefore, the 100 ug/L and 200 ug/L isoconcentration contours shown at -400 ft, msl were extended to just above the surface of the Raritan Clay (simulated at approximately -485 ft, msl in the study area). Plan and cross section views showing the initial extent of the estimated TCE plume is shown on **Figures 10** and **11**, respectively.

The existing plume, as delineated based on observed data, was used as the model initial condition and a continuous source was not simulated.

Transport Properties

Magothy aquifer transport properties are shown in **Table 2**. Transport parameters were taken from the FS simulations and are based on typical values used in various groundwater models on Long Island. Based on total organic carbon collected from the site during the test boring for EW-01 (**Table 3**), the retardation factor was increased from 1.3 to 2.37. Total organic carbon was collected in 25

Table 2
Transport Parameters for TCE and PCE in the Magothy Aquifer

Compound	Retardation Factor (dimensionless)	Effective Porosity (dimensionless)	Longitudinal / Transverse Dispersivity (ft)	Vertical Dispersion Anisotropy Ratio (dimensionless)
TCE	2.37	0.2	30 / 3	0.1

Table 3
Total Organic Carbon Collected during TB-01

Depth (ft below ground surface)	Total Organic Carbon (TOC; mg/kg)
80-82	223
150-152	481
225-227*	14,266
215-217	1,098
230-232*	12,675
235-237*	24,125
245-247	1,245
260-262	796
270-272	305
280-282*	32,810
285-287	3,807
290-292	1,457
295-297	652
310-312	406
315-317	830
325-327	830
330-332	845
340-342	3,464
350-352	521
355-357	643
360-362	618
370-372	1,421
380-382	611
390-392	754
400-402	588
405-407	375
410-412*	13,453

*not used to calculate average retardation factor.

two-foot intervals. There were 5 intervals throughout the boring that contained very high amounts of organic carbon. However, these may be very localized and therefore did not factor into the average. Retardation was calculated as follows:

$R = 1 + (pb/\theta)*(Kd)$

Pb = dry bulk density (gm/cm^3)
θ = volumetric moisture content (dimensionless)
Kd = distribution coefficient for the solute (mL/g)

The distribution coefficient (K_d) for TCE was calculated from published values of the soil-water partition coefficient (K_{oc}) multiplied by the weight fraction of organic carbon in the sediment. The Koc value for TCE used to calculate K_d was 152 mL/g (from Fetter, 2001). Dry bulk density was assumed to be 1.7 g/cm^3 throughout the Magothy (from RI Investigation). Volumetric moisture content was assumed to be 0.20, consistent with effective porosity values used in the transport simulations and consistent with the high end of effective porosities modeled during the FS. The larger effective porosity provides more conservative estimates of clean-up times.

Simulated TCE Concentrations

Transport of the TCE plume shown in **Figures 10** and **11** was simulated using the updated extraction alternative. **Figure 12** shows the plan view distribution of the maximum simulated TCE concentration in any model layer after 10 years for the revised extraction scenario (starting from the portion of the plume that was greater than 100 ug/L). As shown on the figure, no portion of the existing plume greater than or equal to 100 ug/L migrates downgradient past the southern extraction well system. The model simulation includes the three wells pumping a total of 225 gpm continuously.

Simulated concentrations in the southern extraction wells over time are shown on **Figure 13**. Simulated concentrations are below 5 ppb after approximately 27 years, although concentrations fall below 5 ppb in SEW-1D after approximately 17 years. Pumping rates should be adjusted accordingly, based on future water quality data. It should be noted, however, that these simulations do not account for possible tailing effects due to matrix/low permeability zone diffusion.

Summary

Containment of the portion of the Old Roosevelt Field TCE plume greater than 100 ppb south of the Garden City wells can be achieved with a three well scenario at pumping rates of 225 gpm. Although the model simulation includes a specific pumping rate for each of the three proposed southern extraction wells, the pumping rate of each can be adjusted accordingly based on future water quality data.

Although there is some uncertainty as to the extent of TCE and PCE contamination at depths beyond Port 1 of SVP-10 and SVP-11, installation and operation of the deep southern extraction well will capture potential deep contamination (otherwise not captured by the Garden City wells) and prevent it from migrating further south.

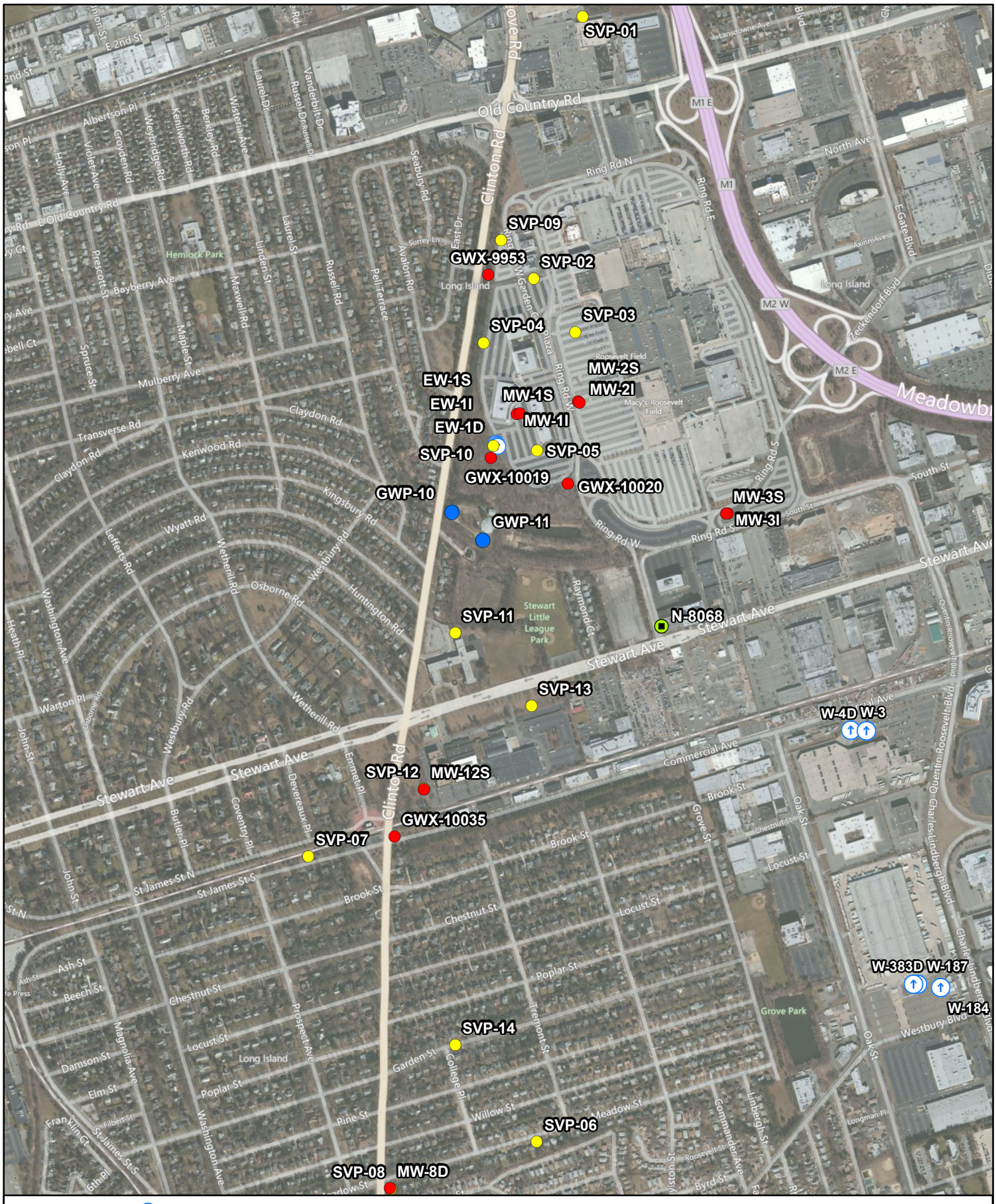
References

CDM Smith. 2007. Old Roosevelt Field Groundwater Model and Transport Simulations. Technical Memorandum, August 13, 2007.

CDM Smith. 2008. Old Roosevelt Field Groundwater Model: Additional Refinements, Calibration, and Simulations for Design of a Pump and Treat System. Technical Memorandum, August 28, 2008.

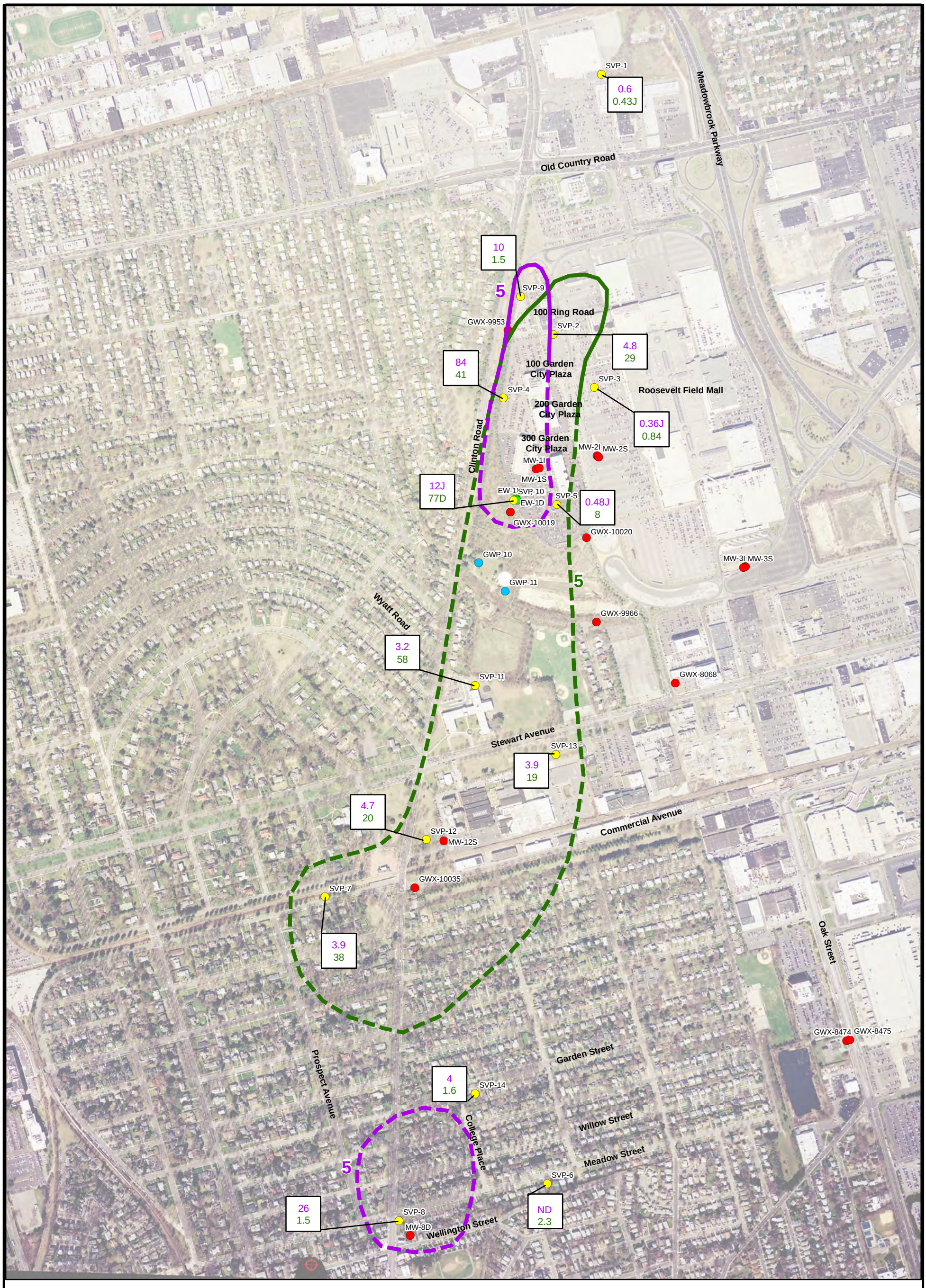
CDM Smith. 2011. Old Roosevelt Field: Simulation of Aquifer Test and Model Refinement. Technical Memorandum, April 13, 2011.

C.W. Fetter. 2001. Applied Hydrogeology, 4th Ed. Prentice-Hall, Inc. Upper Saddle River, New Jersey.



CDM Smith

Figure 1
Well Locations
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York



Existing Monitoring Wells
Supply Wells
Multiport Wells
Extraction Wells

PCE Isoconcentration Contours; PCE values in pink

TCE Isoconcentration Contours; TCE values in green

Note: All values are in µg/L

*Posted PCE and TCE results are from the port closest to 225 feet bgs.

ND = Not Detected
J = Estimated value
D = Diluted Result
bgs = Below Ground Surface

N

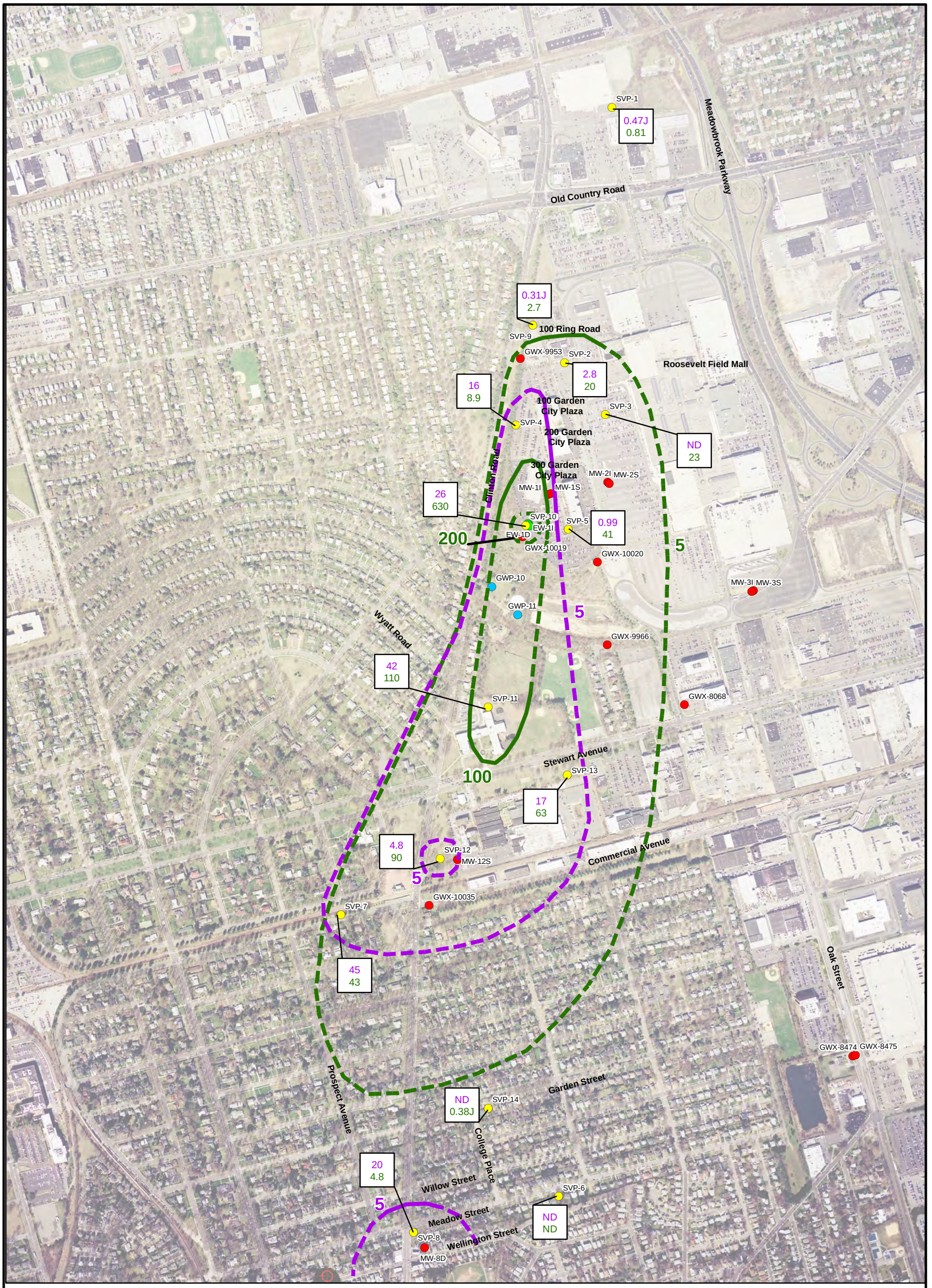
0 300 600

Feet

Figure 2a

Baseline RA/Round 5 PCE and TCE Isoconcentration Contours (225 feet bgs*)
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM Smith



Existing Monitoring Wells
Supply Wells
Multiport Wells
Extraction Wells

PCE Isoconcentration Contours; PCE values in pink

TCE Isoconcentration Contours; TCE values in green

*Posted PCE and TCE results are from the port closest to 320 feet bgs.

Note: All values are in µg/L

ND = Not Detected
J = Estimated value
bgs = Below Ground Surface

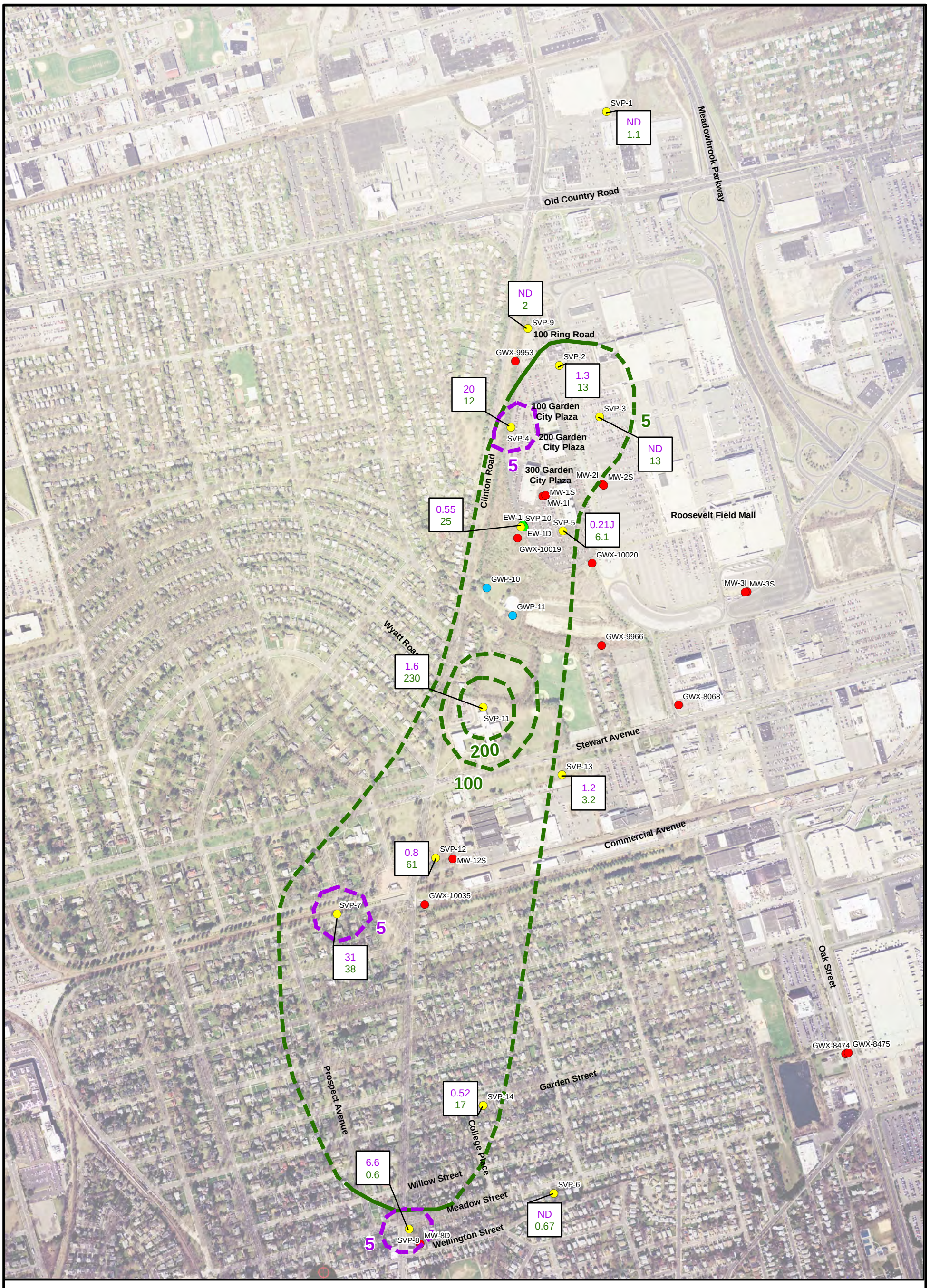
N

0 300 600

Feet

Figure 2b
Baseline RA/Round 5 PCE and TCE
Isoconcentration Contours (320 feet bgs*)
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM Smith



Existing Monitoring Wells
Supply Wells
Multiport Wells
Extraction Wells

PCE Isoconcentration Contours; PCE values in pink
TCE Isoconcentration Contours; TCE values in green

*Posted PCE and TCE results are from the port closest to 400 feet bgs.

Note: All values are in µg/L

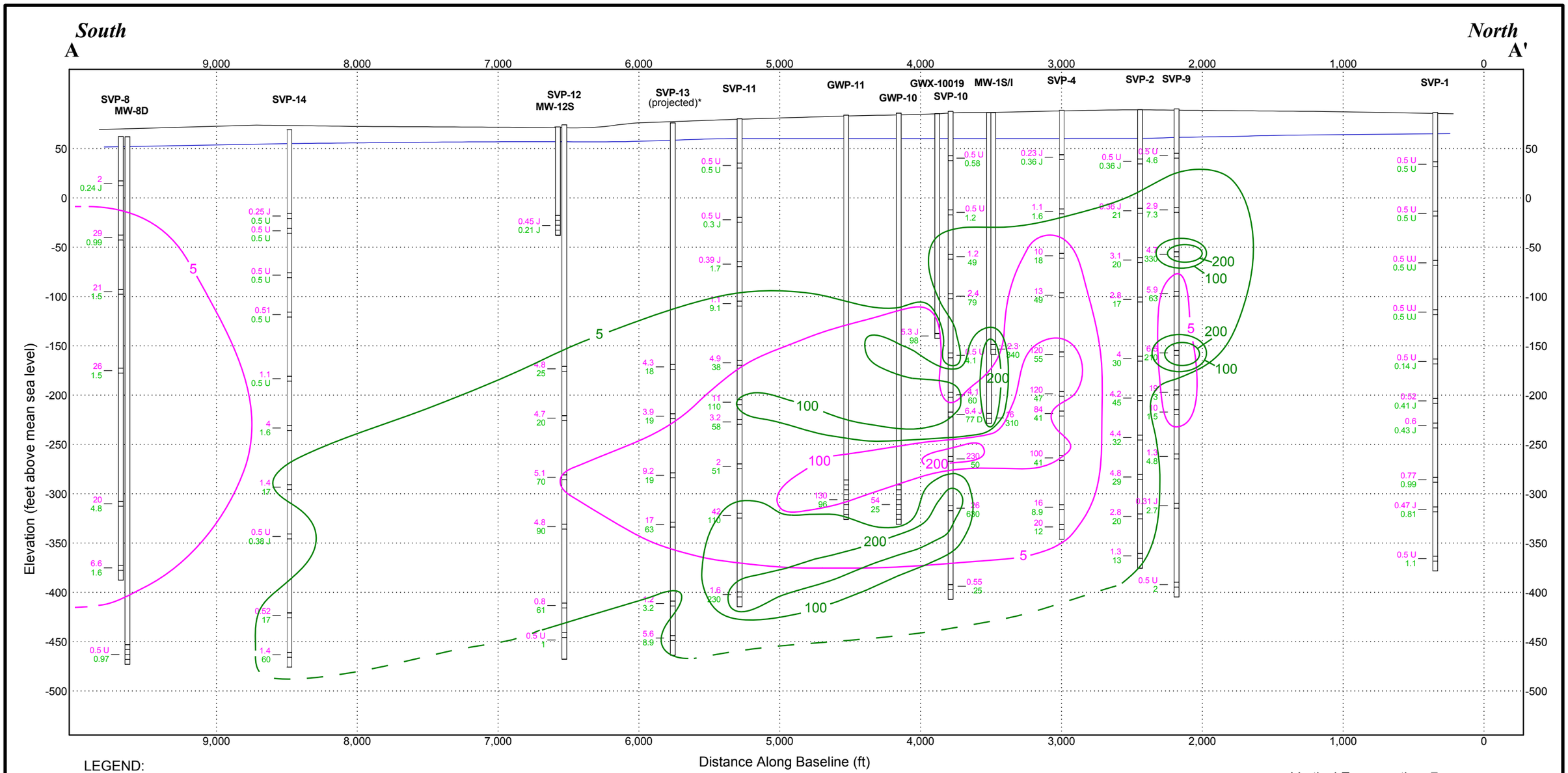
ND = Not Detected
J = Estimated value
bgs = Below Ground Surface

N

0 300 600
Feet

Figure 2c
Baseline RA/Round 5 PCE and TCE
Isoconcentration Contours (400 feet bgs*)
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM Smith



LEGEND:

Well Casing

Well Screen

Westbay Port

Ground Surface

Water Table Surface (September 2011)

PCE Contour (dashed where inferred)

TCE Contour (dashed where inferred)

*Note: SVP-13 is projected from approximately 800 feet east of the cross section line

Groundwater Sample Results
Tetrachloroethene
Trichloroethene
All results in micrograms per liter
U - not detected, detection limit is value to left
J - estimated concentration
D - dilution

Vertical Exaggeration: 7x

Horizontal Scale (feet): 0 — 700

Vertical Scale (feet): 0 — 100

CDM Smith

Figure 3
Round 5 PCE/TCE Cross Section
September 2011
Old Roosevelt Field Contaminated Groundwater Site
Garden City, Nassau County, New York

STANDARD CROSS SECTION ROOSEVELT-1-BRITCH_2010-12-07.GPJ STANDARD_ENVIRONMENTAL_PROJECT.GDT 1/17/12 REV.

CDM Smith

Figure 4
Location of Simulated Southern Extraction Wells
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

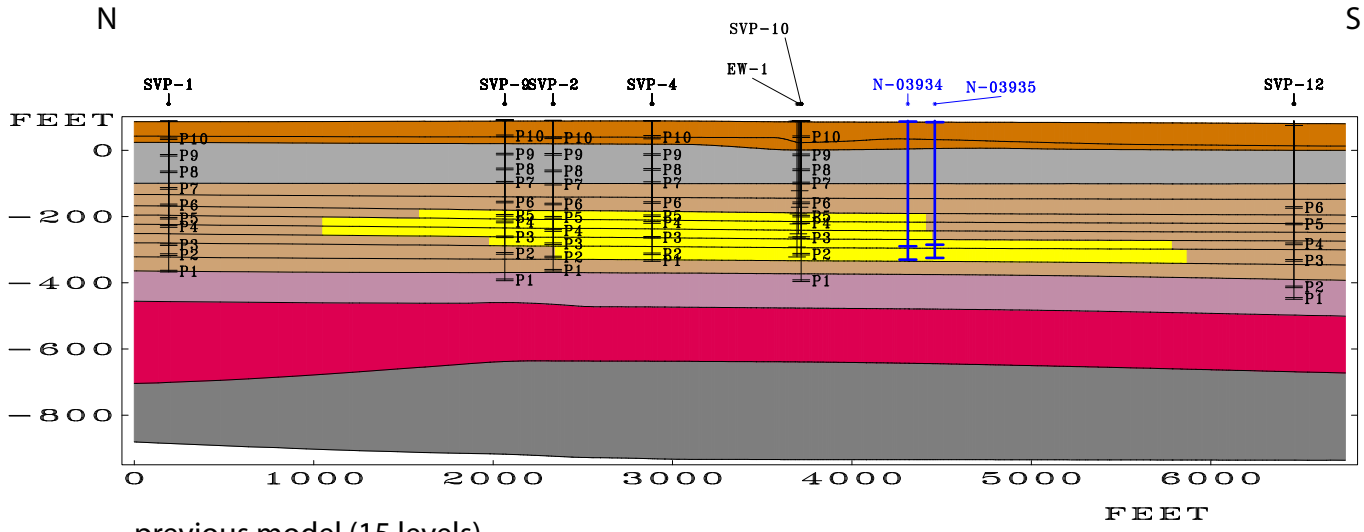
Extraction Well
Industrial (H&C)
Monitoring Well
Multiport Well
Pumping Well

N

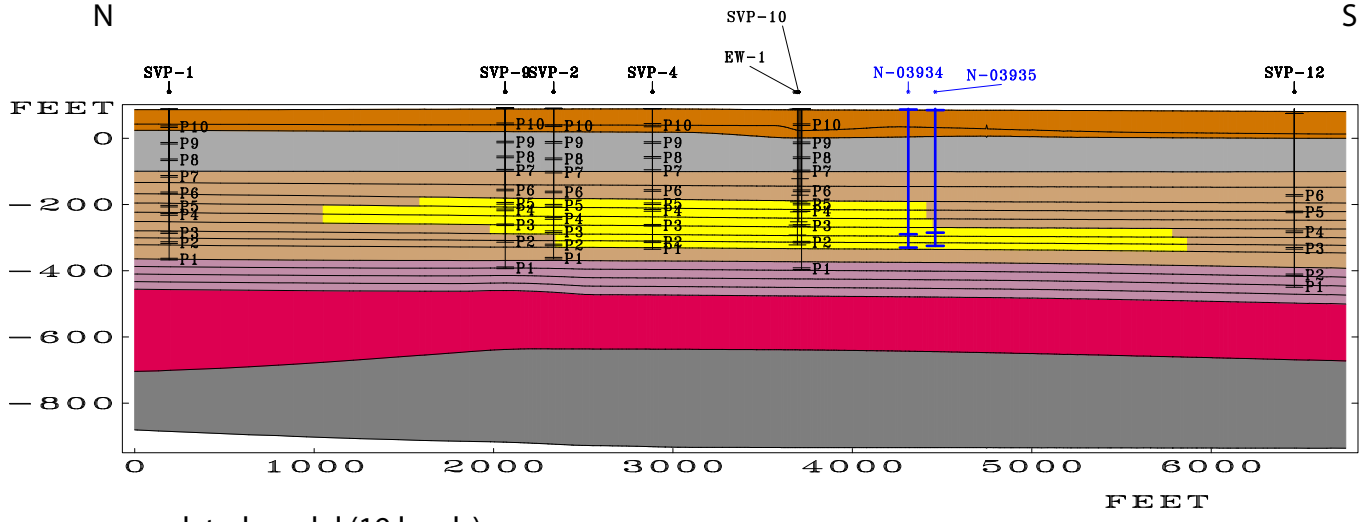
0 150 300 600
Feet

CDM Smith

Figure 5
Refined Finite Element Grid
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York



previous model (15 levels)



updated model (19 levels)

Stratigraphy
- Upper Glacial Aquifer (Kh/Kz = 200/20 ft/d)
- Upper Magothy Aquifer (Kh/Kz = 60/0.6 ft/d)
- Mid Magothy Aquifer (Kh/Kz = 40/0.7 ft/d)
- Mid Magothy Aquifer (Kh/Kz = 80/2.0 ft/d)
- Basal Magothy Aquifer (Kh/Kz = 80/1.2 ft/d)
- Raritan Clay (Kh/Kz = 0.3/0.0001 ft/d)
- Lloyd Aquifer (Kh/Kz = 40/4.0 ft/d)

- Observation Well
- Public Supply Well
- Remediation

GROUND SURFACE

TOP OF SCREEN

BOTTOM OF SCREEN

PROJECTED 500 FT

Figure 6
Refined Finite Element Grid
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM Smith

Simulated Capture Zone from -50 ft, msl
(Head from Approximately MSL)

Simulated Capture Zone from -100 ft, msl

Simulated Capture Zone from -150 ft, msl

15-Yr Contributing Area
- EW-1S
- EW-1I
- EW-1D
- GWP-10
- GWP-11
- SEW-1S
- SEW-1I

Well Type
- Extraction Well
- Monitoring Well
- Multiport Well
- Pumping Well

Simulated Groundwater Head (ft, msl)

N

0 500 1,000 2,000 3,000 4,000 Feet

Figure 7
Simulated 15-Year Capture Zones to Wells within Study Area (225 gpm from Southern Extraction Wells (SEW))
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM Smith

Simulated Capture Zone from -225 ft, msl

Simulated Capture Zone from -275 ft, msl

Simulated Capture Zone from -320 ft, msl

SVP-01 SVP-09 SVP-02 SVP-03 SVP-04 SVP-05 SVP-10 SVP-11 SVP-13 SVP-12 SVP-07
GWX-9953 GWX-10019 GWX-10020 GWX-8068 GWX-10035
MW-1S MW-1I MW-2S MW-2I MW-3I MW-3S MW-12S
EW-1S EW-1I EW-1D
GWP-10 GWP-11
SEW-1I SEW-1D SEW-1S

Well Type
- Extraction Well
- Monitoring Well
- Multiport Well
- Pumping Well

15-Yr Contributing Area
- EW-1S
- EW-1I
- EW-1D
- GWP-10
- GWP-11
- SEW-1S
- SEW-1I

- PCE Isoconcentration Contour; PCE Values in Green
- TCE Isoconcentration Contour; TCE Values in Red
- Simulated Groundwater Head (ft, msl)

N

0 500 1,000 2,000 3,000 4,000 Feet

Figure 8
Simulated 15-Year Capture Zones to Wells within Study Area (225 gpm from Southern Extraction Wells (SEW))
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM Smith

Simulated Capture Zone from -350 ft, msl

Simulated Capture Zone from -400 ft, msl

Simulated Capture Zone from -450 ft, msl

SVP-01 SVP-09 GWX-9953 SVP-02 SVP-04 SVP-03 SVP-10 MW-1S MW-1I MW-2S MW-2I EW-1S EW-1I EW-1D SVP-05 GWX-10019 GWX-10020 MW-3I MW-3S GWP-10 GWP-11 SVP-11 GWX-8068 SEW-1D SEW-1I SEW-1S SVP-13 SVP-12 MW-12S GWX-10035 SVP-07

Well Type
- Extraction Well
- Monitoring Well
- Multiport Well
- Pumping Well

15-Yr Contributing Area
- EW-1D
- GWP-10
- GWP-11
- SEW-1I
- SEW-1D

- PCE Isoconcentration Contour; PCE Value in Green (ppb)
- TCE Isoconcentration Contour; TCE Value in Red (ppb)
- Simulated Groundwater Head (ft, msl)

N

0 500 1,000 2,000 3,000 4,000 Feet

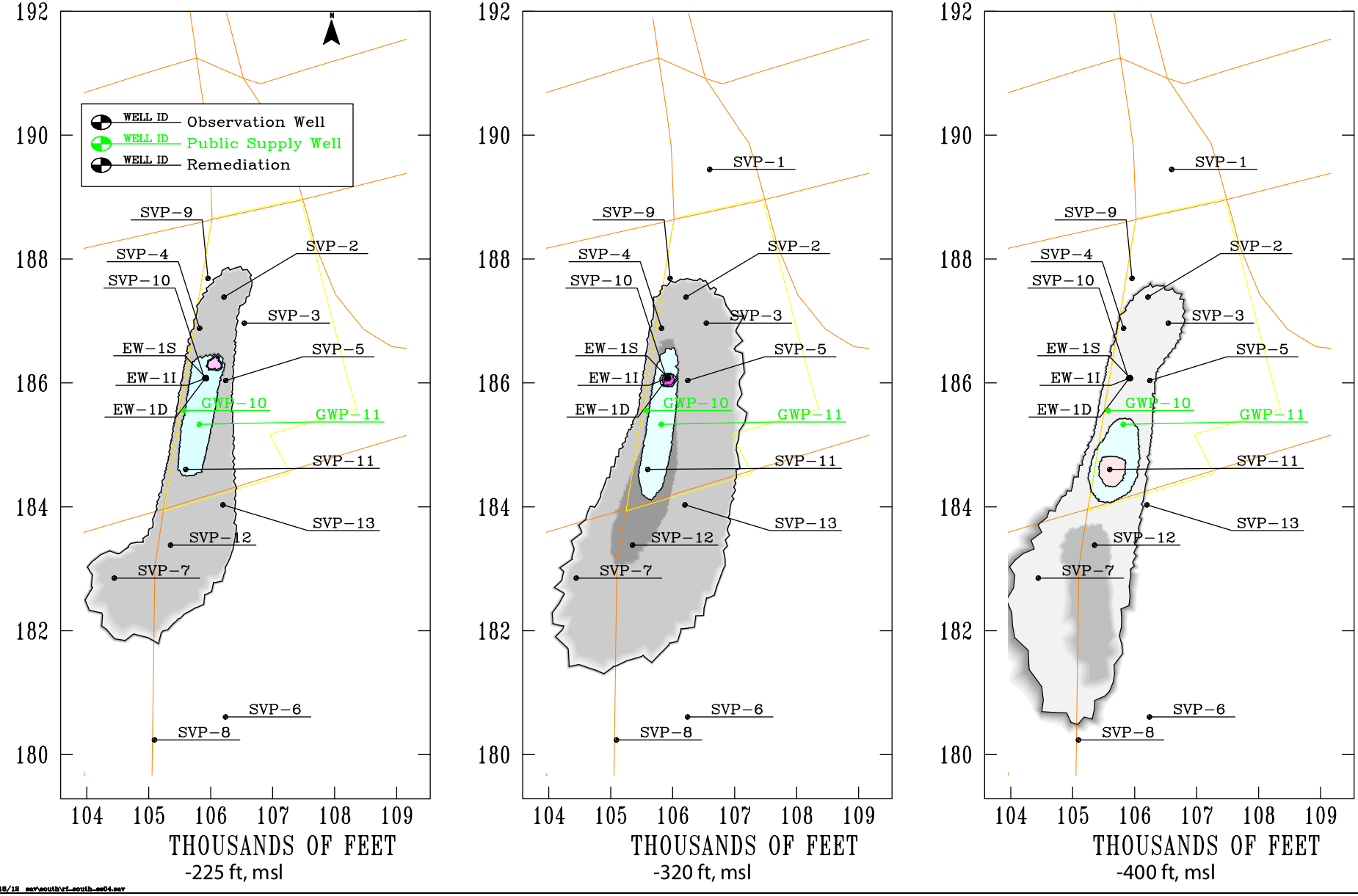
Figure 9

Simulated 15-Year Capture Zones to Wells within Study Area (225 gpm from Southern Extraction Wells (SEW))

Old Roosevelt Field Contaminated Groundwater Site

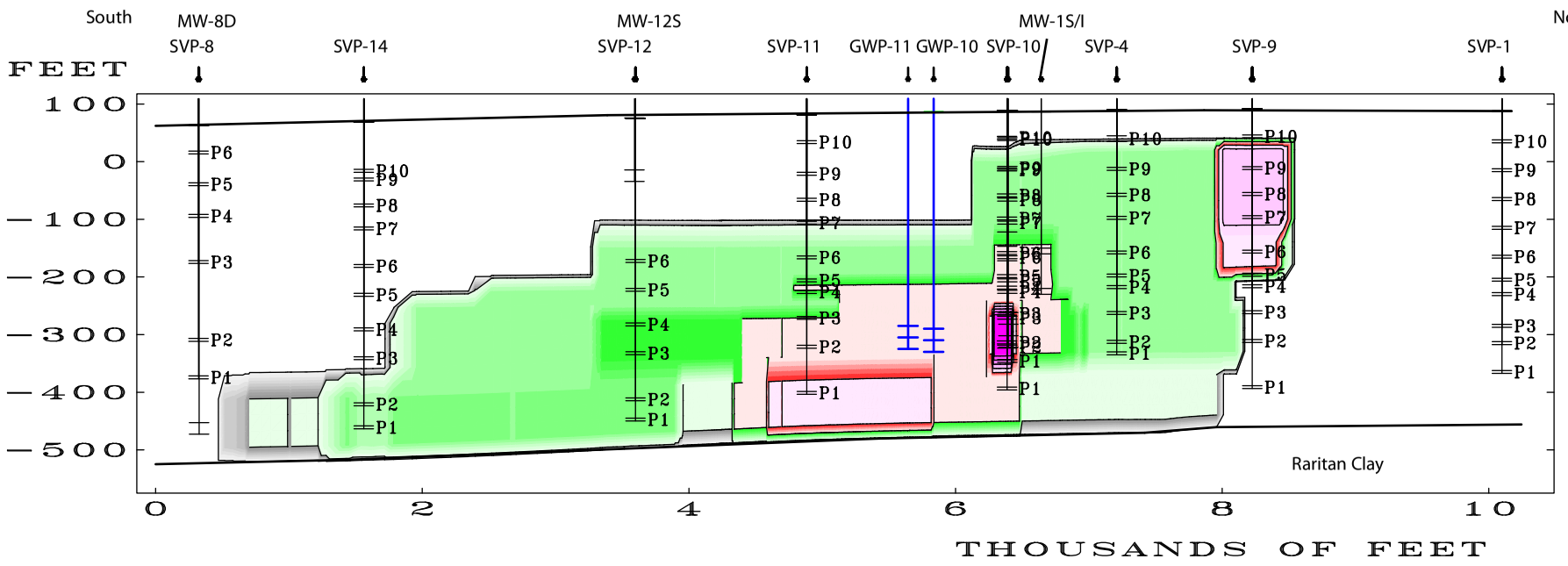
Nassau County, New York

CDM Smith



CDM Smith

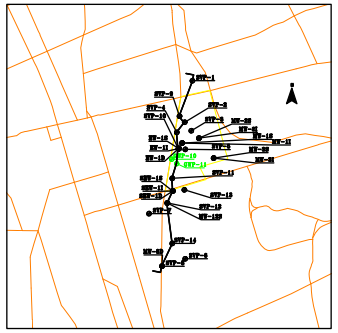
Figure 10
Starting TCE Plume in Model Simulations
Old Roosevelt Field Contaminated Groundwater Site



TCE

- 1 to 10 ug/L
- 10 to 100 ug/L
- 100 to 200 ug/L
- 200 to 630 ug/L

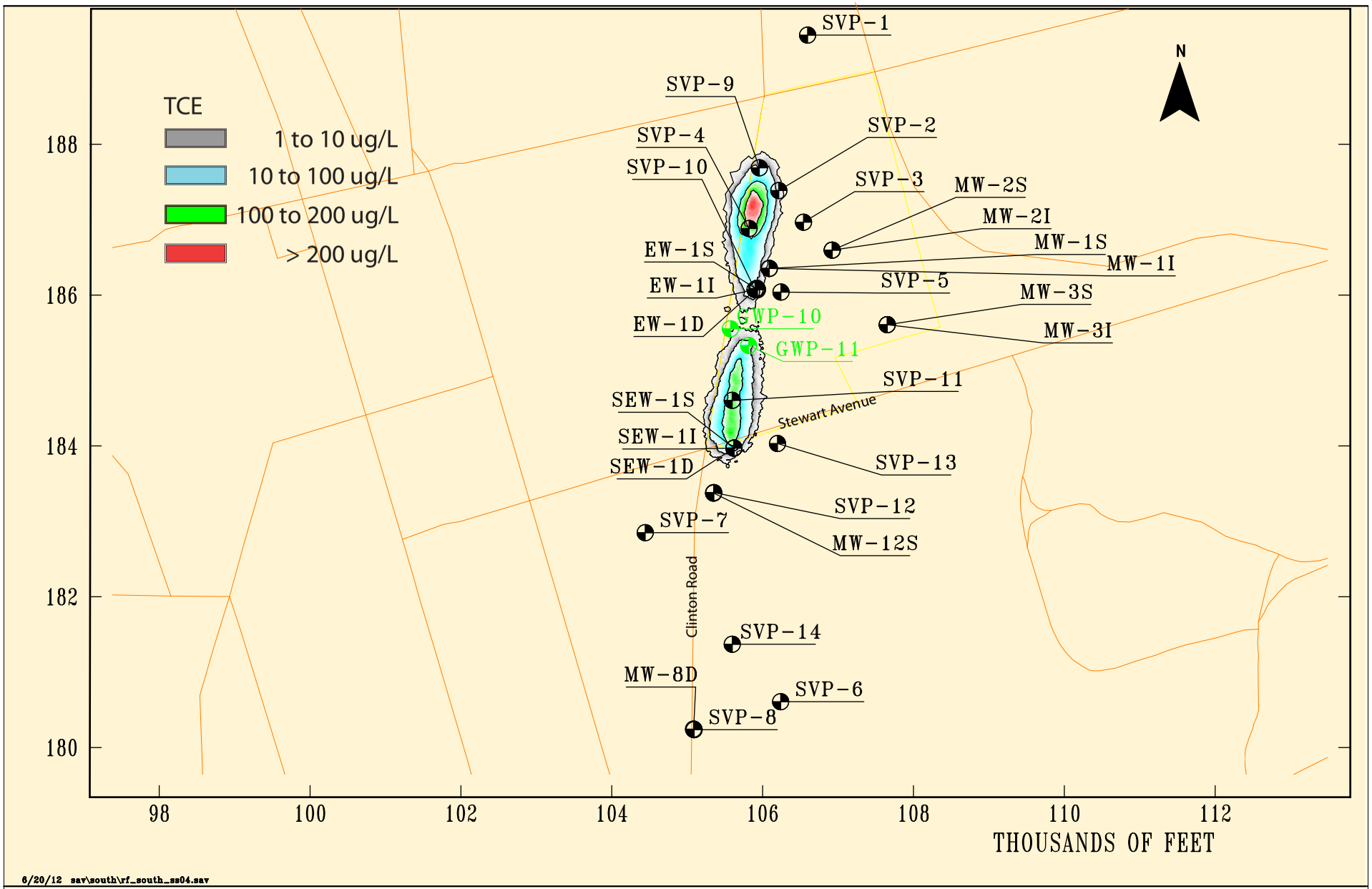
CROSS SECTION DD



6/20/12 sav\south\rf_south_ss04.sav

CDM Smith

Figure 11
Cross-Section Showing Simulated Starting TCE Plume
Old Roosevelt Field Contaminated Groundwater Site



CDM Smith

Figure 12
Simulated TCE Concentrations after 10 Years (starting concentrations > 100 ug/L)
Old Roosevelt Field Contaminated Groundwater Site

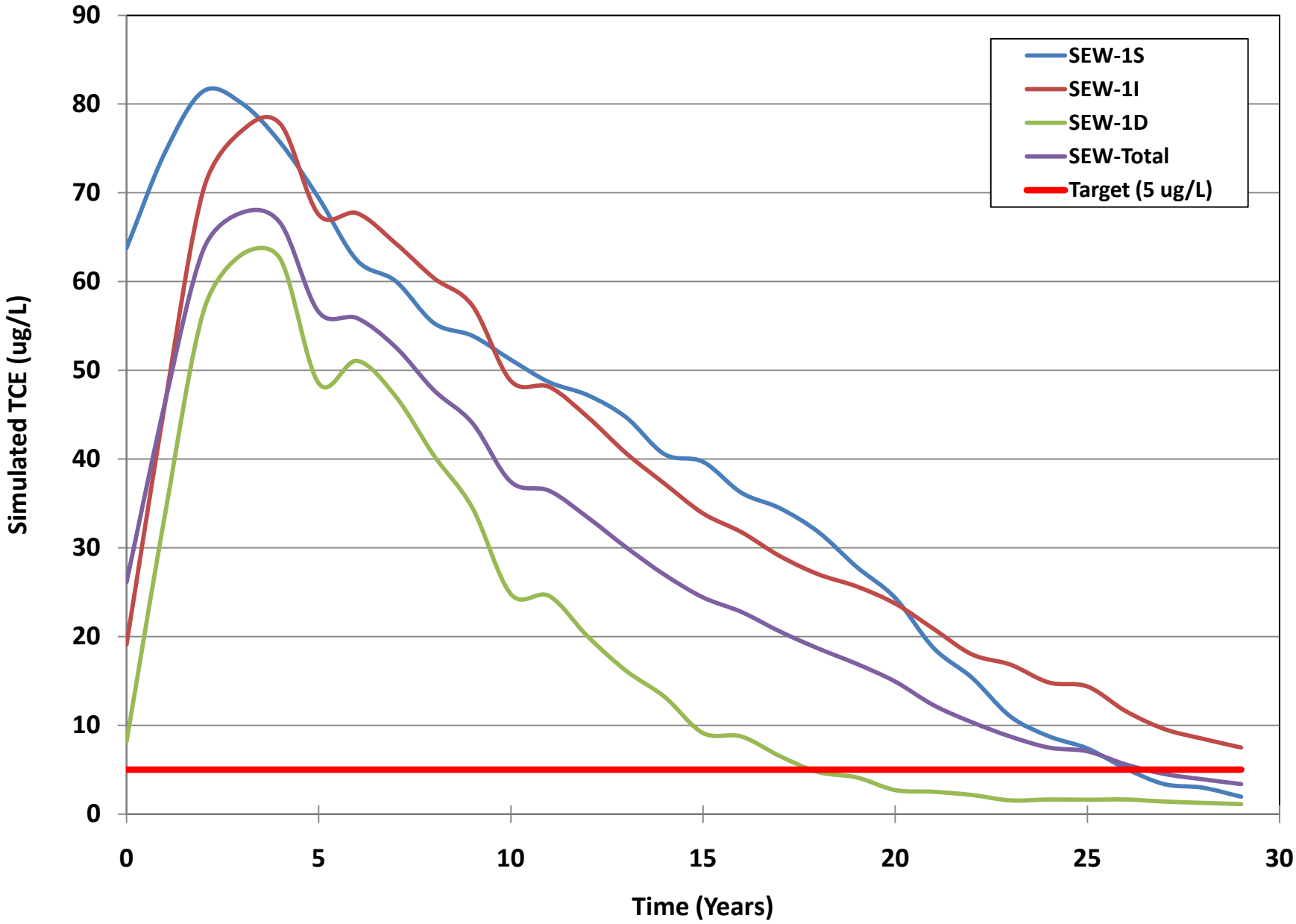


Figure 13
Simulated TCE Concentration in Southern Extraction Well System
Old Roosevelt Field Contaminated Groundwater Site